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Discussion Paper:

Interaction between Art.6 of the Paris Agreement and the Montreal Protocol/Kigali Amendment

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Executive Summary

Hydrofluorocarbons (HFCs) are low ozone depleting substances (ODS)[1] used mainly as refrigerants, as well as greenhouse gases (GHGs) with high global warming potentials (GWP). Their emissions are currently growing quickly because under the Montreal Protocol (MP) they have been promoted as substitutes for ozone-depleting hydrochlorofluorocarbons (HCFCs). However, due to the growing recognition of their detrimental effects on global climate, with the adoption of the Kigali Amendment (KA) to the MP in 2016, a phase-down schedule for HFCs for the next decades was agreed. The HFC phase- down, if successful, will contribute significantly to the Paris Agreement (PA) to the United Nations Framework Convention on Climate Change (UNFCCC) adopted in 2015 which aims to keep global temperature rise to less than 2°C through increasingly ambitious Nationally Determined Contributions (NDCs) for GHG mitigation.

The interaction and mutual impacts of the KA and the PA remain unclear, as their respective rules are still under development. Their interplay should be managed in a way that triggers transformational change in the refrigeration, air conditioning, cooling and foam for insulation (RACF) sectors, promoting the switch to low-GWP alternatives, ideally to natural refrigerants such as ammonia, hydrocarbons or CO_2. The earlier action is undertaken, the lower the baselines for the phase-down schedule under the KA, reducing the cumulative overall allowed HFC consumption, thereby also tackling its emission levels. Unfortunately, given the historic fund replenishment levels, it seems unlikely that the Multilateral Fund for the implementation of the Montreal Protocol (MLF) will have enough financial resources at its disposal to finance a transition going beyond the agreed phase-down to trigger the needed transformational change to natural refrigerants. Therefore, other financial incentives need to be harnessed. The market mechanisms under Article 6 of the PA - cooperative approaches (Art.6.2) and a multilaterally governed Sustainable Development Mechanism (Art.6.4) could provide such incentives by generating revenues from the sale of carbon credits generated by HFC abatement. As these revenues depend on the credit price level, a "**division of labour**" could be envisaged: **market mechanisms** would drive the options with low marginal abatement costs while **public climate finance** could harness the higher cost options. This could lead to the emergence of a landscape of 'integrated climate finance' for HFC reduction exceeding by far the limited funding resources of the MLF.

Lessons learned from HFC mitigation projects and the development of corresponding methodologies under the Kyoto Protocol (KP) and its Clean Development Mechanism (CDM) need to be taken into account when designing incentives for HFC mitigation under the KA and PA. CDM projects for HFC-

[1] According to NASA research findings from 2015, HFCs do have an effect on the depletion of the ozone layer, even if only a very limited one. These findings contradict earlier calculations of ODPs based purely on the chemical effects of the gases. As strong radiative forcers, HFCs increase tropospheric and stratospheric temperatures, thereby enhancing ozone-destroying catalytic cycles and modifying the atmospheric circulation. These changes lead to a weak depletion of stratospheric ozone. The effects are rather small, but expected to become more relevant with growing HFC emissions (Hurwitz et al. 2015).

23 reductions in HCFC-22 production very quickly generated hundreds of millions of emission credits at very low abatement costs. However, they were controversial as many observers thought that the resulting profits were excessive and that there were perverse incentives for an increase of HCFC-22 production. This led to a revision of the underlying baseline methodology that eliminated the perverse incentives. The CDM has developed approaches to reduce transaction costs while maintaining environmental integrity. Such **programmes of activities (PoAs)** and **standardized baselines** should be built into **Article 6 pilot activities** for HFC reduction in order to ensure environmental integrity through robust accounting and credible additionality tests. CDM methodologies can also ensure that interventions supported by public climate finance deliver results.

HFC reduction pilots under Art. 6 should focus on upscaled crediting for the introduction of policy instruments that provide grants to convert HVAC production lines, to finance a direct switch to natural refrigerants, and promote the destruction of HFC banks as the latter is currently not covered under the KA. This could involve programmatic approaches based on currently available CDM small-scale methodologies. HFC-23 reduction projects should not be eligible but instead be allocated to the MLF due to their extremely low abatement costs. In order to **reduce the baseline HFC emission levels for the KA phase-down schedule**, a focus should be on activities that deliver early results.

On a more general level, the KA phase-down schedule for HFCs should serve as the NDC baseline with regard to HFC mitigation to avoid perverse incentives to keep HFC production high, but also to facilitate additionality testing of Article 6 or other climate finance activities. MRV systems and data reporting under the KA and PA need to be synchronized so that HFC emission reporting under the KA is mirrored in the NDCs and long-term low-emission development strategies (LEDS) submitted to the UNFCCC.

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Abbreviations

BAT	Best available technologies
BAU	Business as usual
CA	Cooperative approaches
CAR	Climate Action Reserve
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
CER	Certified emission reduction
CFC	Chlorofluorocarbons
COP	Conference of the Parties to the UNFCCC
CO_2e	Carbon dioxide equivalents
DOE	Designated Operational Entities
ETS	Emissions trading scheme
EU	European Union
ExCom	Executive Committee of the MLF
GCF	Green Climate Fund
GCI	Green Cooling Initiative
GEF	Global Environmental Facility
GHG	Greenhouse gas
GWP	Global warming potential
HAT	High ambient temperature
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
HFO	Hydrofluoroolefins
HPMP	HCFC phase out management plan
IEA	International Energy Agency
INDC	Intended nationally determined contribution
IPCC	Intergovernmental Panel on Climate Change
ITMO	Internationally transferred mitigation outcome
JCM	Joint Crediting Mechanism

KA	Kigali Amendment
KP	Kyoto Protocol
LCCP	Life cycle climate performance
LEDS	Long-term low greenhouse gas emission development strategy
MEA	Multilateral environmental agreement
MLF	Multilateral fund for the implementation of the Montreal Protocol
MOP	Meeting of the Parties to the Montreal Protocol
MP	Montreal Protocol
MRV	Monitoring, reporting and verification
NAMA	Nationally appropriate mitigation action
NDC	Nationally determined contribution
NMA	Non-market approaches
ODP	Ozone depletion potential
ODS	Ozone depleting substance
PA	Paris Agreement
PoA	Programme of activities
PUF	Poly Urethane Foam
QELROs	Quantified emission limitation and reduction obligations
RAC	Refrigerant and air-conditioning
RACF	Refrigeration, air conditioning and foam sector
SDG	Sustainable Development Goal
SDM	Sustainable development mechanism
SLCP	Short-lived climate pollutant
TEAP	Technology and Economic Assessment Panel
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary carbon market

1. Introduction

1.1. Background: why are HFCs a problem for the global climate?

In countries with high temperatures, cooling is a basic need. The worldwide demand for refrigeration, air conditioning and foam for insulation (the so-called “RACF” sectors) is rising steadily. Key drivers are a growing population and, above all, a growing middle class, increasing urbanization and economic growth in areas with persistently high temperatures (tropics) or seasonally extreme temperatures (sub-tropics). Moreover, the 1°C temperature rise since the 1980s has led to cooling demand in areas where cooling was previously not required. For example, the unprecedented heat wave in the 2003 summer that led to the deaths of tens of thousands of elderly people in Western and Central Europe triggered legislation to equip old age homes with air conditioning (Les Echos 2004).

Refrigerants have been causing various global environmental problems. In the 1980s, it was discovered that halogenated gases, the chlorofluorocarbons (CFCs), were responsible for the loss of the ozone layer above Antarctica, so they became known as ozone depleting substances (ODS). This led to the Montreal Protocol (MP) which banned use of these gases in 1987, and development of a replacement refrigerant category, the hydrochlorofluorocarbons (HCFCs) with a much lower ozone depleting potential. Subsequently, under various Protocols to the MP, the HCFCs were phased out and replaced by hydrofluorocarbons (HFCs) with little to no ozone depleting potential (ODP).

However, the various categories of ODS replacements are now estimated to become responsible for a significant share of global greenhouse gas (GHG) emissions, because of their high global warming potential (GWP) of 53 (HFC-152) to 14,800 (HFC-23) (see Annex A). Emissions linked to the production and consumption of HFCs are therefore being reported under the United Framework Convention on Climate Change (UNFCCC). HFC emissions are currently increasing at a rate of 10-15% per year, making them one of the fastest growing GHGs globally. Atmospheric measurement proves that emissions of HFCs are now twice as high as those reported to the UNFCCC by developed countries. This implies that developing countries -so far exempted from regular reporting under the UNFCCC- now account for nearly 50% of HFC emissions (IGSD 2018).

Under a business-as-usual (BAU) scenario, a strong increase in direct GHG emissions from refrigerants and indirect emissions from its use of electricity is expected. By 2030, the RACF sector could be responsible for 13% of global emissions. HFCs used in refrigeration and air-conditioning are estimated to provide 20% of total abatement potential across all non CO_2-emitting sectors by year 2030 (GIZ 2016)[2]. In order to lower the GHG emissions a transformational change is needed to introduce

[2] This estimation is taken from the EPA report on marginal abatement costs for non-CO_2 GHGs until 2030. They conclude that with regard to gases, methane (CH_4) mitigation offers the largest potential at or below 0USD/tCO_2e with more than 1 GtCO_2, while the largest abatement potential in one sector can be found in the mitigation of HFC emissions in the refrigeration and air

and disseminate environmentally friendly technologies that neither damage the ozone layer nor contribute to global warming. These technologies use natural refrigerants and foam blowing agents like hydrocarbons, ammonia and CO_2 and have the potential to achieve a rapid reduction of HFC emissions to 85% of emissions compared to baseline levels (UNEP 2017).

HFCs were part of the basket of six types of gases covered by the industrialized country commitments under the Kyoto Protocol (KP). However, no progress was made specifically on this gas category in the Paris Agreement (PA) negotiations adopted in 2015 under the UNFCCC and aiming to reduce global warming to 2°C while striving to reduce it even to 1.5°. Thus focus shifted to the MP as a regime to reduce HFC emissions. With the adoption of the Kigali Amendment (KA) in October 2016, HFC consumption control measured in CO_2e and phase-down to 80-85% compared to baseline levels have now been introduced in the MP. According to IGSD, a faster phase-down of HFCs under the Kigali Amendment from 2020 onwards could prevent 100 to 200 Gt of CO_2e emissions by 2050 and avoid up to 0.5°C warming by 2100, calculating not only the cumulative emissions avoided but also the avoidance of additional HFC banks (2018). The urgent need to increase global GHG mitigation ambition therefore directs a strong focus to assess the practical feasibility of mobilizing this HFC mitigation potential.

The reduction of HFCs under the KA has also been taken up in the special report of the Intergovernmental Panel on Climate Change (IPCC, 2018) on the impacts of global warming of 1.5°C. The summary for policymakers states with high confidence that modelled pathways that limit global warming to 1.5°C involve deep reductions in short-lived climate pollutants (SLCP) including many HFC gases (see Annex A), while at the same time providing direct and immediate population health benefits in all 1.5°C model pathways (IPCC 2018a). In a 1.5°C consistent pathway, fluorinated gases would need to be reduced by roughly 70-80% in 2050 relative to 2010 levels. These would imply that the implementation of the KA would not be sufficient to deliver on the PA's long-term objective of avoiding dangerous climate change, as it would only halve HFC emissions by 2050 compared to 2010. At the same time, Rogelj et al. (2018) highlight that with the application of best available technologies (BAT), potential fluorinated gas emissions could even be reduced by more than 90% in the same period of time. In the context of the publication of the IPCC's Special Report, the Kigali Amendment has also attracted some renewed interest in the broader media highlighting the potential of this "little noticed treaty" to contribute to reaching the goals of the PA and reduce global warming (Harvey 2018).

To spread the technological advances needed for the transformational change laid out in the IPCC special report, extensive financial resources, innovative policy instruments as well as political will are

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conditioning sectors. EPA estimates that 30% of baseline 2030 emissions in these sectors can be abated cost effectively (EPA 2013). A seminal report at its time, the assumptions made with regards to technologies and the methodologies would need to be updated. Furthermore, abatement of black carbon as non-CO_2 GHG is not considered in this report due to lack of comprehensive data, abatement and costs.

needed. Relying solely on conventional financing mechanisms (non-market mechanisms) is not sufficient. As reduction costs for measures in the RACF sectors due to the enormously high climate impact of chemical substances[3] are comparatively cost-efficient (<10 USD / tCO_2e) (EPA 2013), it is appropriate to consider the use of market-based mechanisms, including those established by Article 6 of the PA. It is therefore important to advance the understanding of the interplay of the PA under the UNFCCC and the KA to the MP in order to maximize synergies between those global regimes in order to increase their respective ambition to achieve a climate-friendly and ozone-friendly transformation of the RACF sectors.

1.2. Objectives

The study analyzes the interactions between the Paris Agreement and the Kigali Amendment to the Montreal Protocol, with a focus on the potential of using Article 6 instruments to enhance the ambition of HFC mitigation activities. Both agreements were only adopted very recently in 2015 and 2016 respectively and specific rules are still under negotiations. At this crucial stage of operationalization, this study seeks to inform on ways to enhance synergies and avoid perverse incentives in the implementation of both PA and KA, with regard to pursuing HFC mitigation under the cooperative approaches established in Article 6 of the PA. As the specific regulations for Article 6 are not yet adopted, the analysis draws upon the main lessons from HFC mitigation under the established market mechanism under the UNFCCC, the KP's Clean Development Mechanism (CDM) and its implications as well as the ongoing negotiations on both the detailed rules for the KA and the operationalization of Article 6. Based on the main findings, the study identifies options and recommendations to harness synergies between the KA and PA for enhancing mitigation ambition in RACF sectors.

2. Two international regimes addressing HFCs

With the Kigali Amendment to the Montreal Protocol (MP) regulating the phase down of a greenhouse gas covered by the UNFCCC, two environmental policy regimes overlap in the management of HFCs. On the one hand, there is the "ozone regime" established under the Vienna Convention for the Protection of the Ozone Layer and its MP with the objective to "*protect human health and the environment against the adverse effects resulting from modifications in the ozone layer*". On the other hand, the "climate regime" under the UNFCCC and its underlying Kyoto Protocol (KP) and Paris Agreement (PA) aim to stabilize "*greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*". These two regimes are closely intertwined: Most ozone depleting substances (ODS) have also a global warming potential (GWP), so their management as well as the overall protection of the ozone layer has direct implications on limiting the anthropogenic climate change (UNEP Ozone Secretariat 2016). Velders et al. (2007)

[3] Most common refrigerators include HFC134a with a GWP 100-yr of 1430 as well as HFC blends such as R404a, R410A, R407C and R507A with GWPs ranging from 1774-3985 (EPA 2013).

state that the emission reductions achieved by the MP from phasing out ODS is already larger than the reduction target of the first commitment period of the KP. In the period 1989-2013, elimination of controlled ODS led to the co-benefit of reducing 135 Gt of cumulative CO_2e emissions (UNDP 2018). From 1997 to 2012, developed countries and economies in transition accounting for 39% of 2010 global GHG emissions committed under the KP to a 5% decrease between 2008 and 2012 in comparison to base-year emissions (mostly 1990). This target has been overachieved in total by 2.4 $GtCO_2e\ yr^{-1}$ (Shishlov et al. 2016).

So far, the UNFCCC only covered GHGs not controlled by the MP and thus HFCs. Now with the Kigali Amendment and the introduction of HFCs to the controlled substances under the MP, there is a clear overlap of mandates between both regimes. Still, both multilateral environmental agreements (MEA) have their own focus: the MP aims to introduce control measures for production and consumption, while the UNFCCC focusses on reducing emissions (UNEP Ozone Secretariat 2016). Therefore, regulatory measures on HFCs under UNFCCC and the MP are not exclusive of each other. However, the overall management of potential synergies will have significant implications on the action on the ground and can offer substantial benefits, as explored in the following sections.

2.1. The evolving nature of policy regimes under the UNFCCC

The climate regime is evolving from the top-down rule setting system of the KP to a bottom-up regime embodied in the PA adopted in 2015, aiming to deliver the ratcheting-up of national pledges of a widely varying nature over time, facilitated by enhanced transparency and stocktaking. Whereas mitigation commitments of Parties under the KP were limited to the Annex-B-Countries (industrialized countries), the PA relies on “nationally determined contributions” (NDCs) from all Parties. These can take widely varying characteristics, showing a move away from bifurcation.

2.1.1. The Kyoto Protocol and the role of HFCs in the CDM

Adopted in December 1997 and entering into force in February 2005, the Kyoto Protocol operationalizes the UNFCCC’s objective of stabilizing atmospheric concentrations of GHGs to prevent dangerous global warming. To do so, the KP defined legally binding GHG emission commitments (“quantified emission limitation and reduction obligations”, QELROs) for 38 industrialized countries, the so-called Annex B parties, which cover 6 categories of GHGs, including HFCs. QELROs defined an emission budget (“assigned amount”) for the first commitment period covering 2008-2012. In order to reduce the costs of attaining the QELROs, market mechanisms were created, allowing the Annex B Parties to add / or subtract emission units from their initial assigned amount. Among these instruments, the Clean Development Mechanism (CDM) was defined in Article 12 of the KP as a project-based mechanism. The CDM created a mechanism in which emission credits, Certified Emission Reductions (CERs), can be created through mitigation projects in developing countries not subject to QELROs. The CDM is administered by an UNFCCC body, the CDM Executive Board (CDM EB). In order to ensure the environmental integrity of CERs, detailed modalities and procedures for the registration of

CDM projects were developed from 2001 onwards, defining a project cycle, requirements for third party validators and verifiers (Designated Operational Entities, DOEs). Rules are simplified for micro- and small-scale projects with less than 60,000 t CO_2e reduction per year. Project developers and the UNFCCC Secretariat can propose methodologies for determining project baselines and monitoring emission reductions. Out of the 187 approved methodologies, large and small scale, approved to date, the following methodologies focus on the reduction of HFCs (UNFCCC 2017):

Production side - large scale

- **AM0001 Decomposition of fluoroform** (**HFC-23) waste streams.** This methodology applies to project activities which capture and decompose HFC-23 formed as a by-product in the production process of HCFC-22, a refrigerant. 23 projects were proposed under this methodology and to date 19 are registered. These are the largest of all CDM projects worldwide. To date, they have issued 540 million CERs and are expected to generate a total of 1.6 billion CERs over their crediting period.

Their history is very interesting (see Michaelowa and Buen 2012, p. 7ff): While some climate policy specialists had stated for several years that HFC-23 reduction would be relatively straightforward and low-cost (see e.g. Blok et al. 1999), no one had really followed up on these reports due to a lack of incentives. However, in early 2003, the UK company INEOS Fluor submitted a proposal for a baseline methodology on the thermal destruction of HFC-23. The accompanying project document for a plant in Korea estimated an annual emission reduction of 1.4 million t CO_2e. When the CDM EB approved the methodology without ado in July 2003, international donor organizations and consultants swarmed out to identify similar projects. And they found them – in China and India. Already in February 2004, the UN Environment Programme (UNEP) organized an 'International Workshop on HFC-23 Clean Development Mechanism (CDM) Project Cooperation in China', with representatives of 11 fluorochemical plants attending. At this workshop, a document bundling together 12 HCFC-22 production sites with a total annual volume of 58.5 million CERs was presented by a representative of the German Technical Cooperation (Sicars 2004).

But China did not want this bonanza to fall into the hands of development cooperation people; it took its time and let the potential buyers woo the Chinese government, especially from Japan and Italy (see Schwank 2004). At the same time, a giant HFC-23 project was already getting host country approval in India with the support of INEOS Fluor. It estimated an annual CER volume of 5 million at an investment cost of only a few million Euro. Now the chemical giant Dupont started to grasp the enormous impact of the CDM on the revenues of its competitors. In June 2004, it thus wrote a letter to the CDM EB arguing that the baseline HFC-23 emissions rate should be reduced from the IPCC default level of 4% to the 1.37% achieved by a Dupont plant in the US. This lobbying was successful in triggering a revision of the methodology, which now woke up the community. In October 2004, Schwank (2004) rang the alarm bell warning that HFC-23 CDM projects would impede the phaseout of HCFC-22 agreed under the Montreal Protocol and reduce the CER price. Schneider et al. (2004) argued that the CDM introduced perverse incentives to increase HCFC-22 production and thus HCFC-22 plants

that started construction after April 2003 should be excluded. Eventually this view prevailed and the CDM EB revised the methodology, limiting its use to plants that had operated for at least three years before the end of 2004.

In late 2004, the Chinese government embarked on a bold move by taxing HFC-23 projects at 65% of their CER revenue. Once state revenues had been assured, the government moved swiftly to maximize these revenues, and minimize transaction costs through large contracts. As Italy had been quite pushy to get its hands on HFC-23 CERs from China since October 2003 (Russo and Lu 2005), a Sino-Italian workshop on HFC-23 projects in China was organized in January 2005 that brought together over 100 participants. While the large Italian utility ENEL and the Italian government did get a significant share of the CER bonanza, the lion's share was gobbled up by the World Bank. The Bank behaved like a hedge fund and rapidly set up an 'Umbrella Carbon Facility' (UCF) whose sole purpose was to collect sufficient funding from private buyers to engage in a massive HFC-23 CER acquisition contract (World Bank 2006). In August 2006, the UCF spent 737.6 million US$ to acquire 129.3 million CERs (World Bank 2011) from two HFC-23 projects. Quickly, all other eligible Chinese HFC-23 projects – i.e. those existing before 2005 -were contracted and plants in other countries followed. Currently, only one eligible opportunity has not been implemented – a plant in Venezuela, where the World Bank was pushing strongly, but Venezuelan president Chavez' aversion against market mechanisms prevailed.

Academics and researchers started to criticize the HFC projects early on for taking up "low hanging fruits" and not having sustainable development co-benefits. Wara (2007) argued that HFC-23 projects should be excluded from the CDM due to their high rents. He suggested that public funds could just finance the abatement costs. In early 2010, the NGO CDM Watch launched a campaign against HFC-23 projects, arguing that project developers had kept the HFC-23 generation level artificially high as they would earn more money by producing as much HCFC-22 as they could and give it away for free due to the high CER revenues. This caused the CDM EB putting the HFC-23 methodology on hold. Subsequently, the methodology was made very stringent with no possibility to attain credits for increased HCFC-22 production (see detailed discussion in Munnings et al. 2016). CDM Watch scored a total victory, with the EU Commission prohibiting use of CERs from HFC-23 projects in the EU Emissions Trading Scheme from April 2013 onwards (EU Commission 2011). All other industrialized countries followed suit in prohibiting HFC-23 CER use for their domestic trading schemes. Currently, CERs from HFC-23 projects are a "nonsalable" commodity due to the absence of demand. This persist despite researchers proving that HFC-23 CDM projects actually reduced emissions by much more than the volume of CERs received (Munnings et al 2016).

- **AM0071 Manufacturing and servicing of domestic and/or small commercial refrigeration appliances using a low GWP refrigerant.** The methodology applies to project activities done by a manufacturer of domestic refrigeration appliances or small commercial refrigeration appliances or both domestic and small commercial refrigeration appliances that aim to reduce GHG emissions by switching refrigerants with high GWP to low GWP refrigerant. To date there are no projects registered under this methodology.

Production side - small scale

- **AMS-III.N. Avoidance of HFC emissions in Poly Urethane Foam (PUF) manufacturing.** This small-scale methodology applies to project activities that avoid the fugitive emissions of HFC-134a gases used as a blowing agent during the production of Poly Urethane Foam (PUF) in an existing or a Greenfield manufacturing facility. Out of the 4 proposed projects, all of them by India, 3 are registered expecting an accumulated emission reduction of 0.6 $MtCO_{2e}$ by 2030.

Consumption side - small scale

- **AMS-III.AB. Avoidance of HFC emissions in Standalone Commercial Refrigeration Cabinets.** The aim of this methodology is the avoidance of HFC (HFC 134a) emissions during the life cycle of commercial standalone refrigeration equipment (0.2kg < HFC usage < 6kg). The measure is to introduce new refrigeration cabinets, that are equal or more energy efficient and that use low GWP refrigerant. To date, no projects have been registered under this methodology.
- **AMS-III.X Energy Efficiency and HFC-134a Recovery in Residential Refrigerators.** The aim of this category is to replace existing, functional domestic refrigerators with more efficient units utilising refrigerants and foam blowing agents that have no ODP and low GWP. To date, only one project in Brazil was submitted intending to reduce 0.02 $MtCO_{2e}$ by 2030 but has not yet been validated.

Small scale methodologies are often used in PoAs, which can also be implemented in multiple countries without a limit to their scale. This scalable approach makes them a good basis for methodological approaches for Article 6 pilots.

Projects on HFC mitigation have also been pursued in cooperation mechanisms outside of the UNFCCC. The Japanese Joint Crediting Mechanism (JCM) has developed and applied a methodology ID AM003 on energy efficiency in the context of the RACF sectors (GoJ 2015). These projects aim to save energy by introducing high efficiency commercial refrigerators /chillers using natural refrigerants (NH_3 and CO_2) to the food industry cold storage and frozen food processing plants in Indonesia (JCM 2018) whereas there is no specific switch from HFC to natural refrigerants. The focus of the methodology is on energy efficiency, the use of natural refrigerants comes as co-benefit in emission reduction which does not generate carbon credits.

There have also been projects in the context of the voluntary carbon market (VCM) (WB n.D.). It accepts ODS destruction projects for foam blowing agents such as HFC-134a and HFC-245fa (CAR 2017). Until 2016, credits totaling 4.4 $MtCO_2e$ were created under the Voluntary Markets and ODS Destruction Protocols (EPA 2018). The Verified Carbon Standard (VCS), now Verra, since 2014 no longer approves or accepts for consideration new methodologies and projects relating to HFC-23 (PR Newswire 2014).

In November 2017, the CDM EB approved a new methodological tool (TOOL29) for “determination of standardized baselines for energy-efficient refrigerators and air-conditioners”. CDM standardized

baselines have been recognized as a valuable tool that lowers transaction costs as they simplify MRV requirements and often determine automatic additionality. The tool covers the use, distribution and sale of refrigeration and air-conditioning (RAC) equipment for residential and household application, including (a) greenfield (new sales) refrigerators and air-conditioners; (b) replacing existing refrigerators with efficient ones and (c) for emissions from the refrigerants contained in baseline refrigerator and air-conditioner equipment (CDM EB 2017). However, this tool does not capture any HFC mitigation outcomes. Still, its recent approval demonstrates interest in the sector by the UNFCCC regulators which may be conducive for deeper integration of KA and PA approaches.

After having reviewed the status quo of HFC projects under the KP, we now look into how international policy makers address the sector under the PA.

2.1.2. The role of HFCs under the Paris Agreement

The PA foresees that Parties should move in their NDCs towards formulating economy-wide emission reduction targets over time, which then would include HFC emissions automatically. Article 4.19 of the PA furthermore encourages Parties to formulate and communicate long-term low greenhouse gas emission development strategies (LEDS) to orient the nationally determined action on the fulfillment of the long-term objective to reduce global warming. Article 6 of the PA establishes two market mechanisms and one non-market mechanism for voluntary cooperation in the implementation of NDCs in order to achieve higher ambition, promote sustainable development and environmental integrity (UNFCCC 2015). The PA entered into force in record time of less than a year after signature and 174 countries have ratified it to date. While the US have declared to withdraw from it, the PA remains a firm basis of international climate policy.

The role of HFCs in NDCs

HFCs were underrepresented in the first generation of NDCs submitted by Parties since 2015. A recent survey on general SLPC inclusion- to which many HFCs belong - in Asian NDCs suggested that this was due to a limited awareness of environmental policymakers on the role of these substances, a lack of coordination between different government agencies as well as a lack of data and robust inventories on the respective emissions (Akahoshi et al. 2018).

If addressed, HFC emissions figure in NDCs in three different ways. Firstly, indirectly in 70 of the 174 NDCs through economy wide GHG targets that include all seven GHG categories covered by the UNFCCC. Secondly, seven out of these 174 NDCs listed policies and actions to reduce HFC emissions, either on the production or the consumption side (see Annex B). Out of these seven countries, Nigeria and Ghana addressed HFC emissions in the context of an expected growing demand for cooling. Only the Chinese NDC included an HFC-specific quantitative outcome for emission reductions (WRI & Oxfam 2018).

In 2020, NDCs from Parties are to be resubmitted or updated. Given the fact that political and financial support to climate action is expected to be focused on NDC implementation there is a clear incentive

to include HFCs in the second round of NDCs. Meanwhile, HFC inclusion in NDCs is also dependent on addressing current gaps in in-country capacity and coordination (see Akahoshi et al. 2018). Coherent action would need an amelioration of RACF sector inventories, the assessment of technological mitigation options and economic impacts, the identification of HFC mitigation scenarios and corresponding policy instruments as well as- especially in developing countries- financial incentives (GIZ 2016).

The role of HFCs in LEDS

SLCPs in general are addressed in several long-term strategies submitted to the UNFCCC, but mostly only in a cursory manner given that LEDS are understood as overall guiding documents. Industrialized country LEDS cover HFC mitigation in line with their phase-down schedule under the KA which requires a phase-down of HFC consumption by 2036. The current UK policies aim to reduce HFC emissions by 81% from 2015 levels by 2035, in line with the KA and the EU regulation on fluorinated gases (UK 2018). Canada also stresses its support and willingness to implement the KA and foresees to prohibit manufacture and import of products and equipment containing or designed to contain HFCs (Canada 2016). The French LEDS plans to reduce 55% of HFC emissions by 2030 compared to 1990 levels, while Germany simply refers to the EU F-gas regulation obligations (France 2017, BMUB 2017).

Mexico has so far been the only developing country to include HFC emissions into its LEDS. Mexico sets itself the target to accelerate the penetration of low GWP refrigerants and to strengthen best practice programs for refrigeration, recovery and final disposal of CFCs, HFCs and HCFCs (Mexico 2016). The Republic of the Marshall Islands as a small island developing state considers the introduction of appliance standards for air conditioning units and building code reforms to reduce the electricity demand for cooling, thus tackling the indirect emissions in the RACF sector but does not mention HFC-related targets (Republic of the Marshall Islands 2018).

Currently, many countries are in the process of developing their own LEDS. Including a longer-term perspective on HFC mitigation is of particular importance for developing countries, where the phase-down of HFCs is foreseen in the KA to be implemented in the period of 2024-2045 (2047 for some countries), also in order to identify means of raising ambition through earlier action under the Paris Agreement.

The market mechanisms under Art. 6 of the PA as a new avenue for mobilizing HFC reduction

Besides traditional climate finance support via the Green Climate Fund (GCF) under the UNFCCC or the Multilateral Fund for the implementation of the Montreal Protocol (MLF), an avenue for generating financial incentives to HFC mitigation could be using the market mechanisms under Article 6 of the PA.

Article 6.2 allows “cooperative approaches” (CAs) for the transfer of internationally transferred mitigation outcomes (ITMOs) with a limited degree of international oversight to ensure environmental integrity and transparency as well as robust accounting to avoid double counting of emission reductions. CAs could be used to link emission trading schemes (ETS) or other regional mechanisms

such as carbon taxes or baseline-and-credit schemes. The Article 6.4 mechanism, often referred to as "Sustainable Development Mechanism" (SDM), builds on the lessons from the CDM as a UNFCCC centralized crediting mechanism. This includes detailed rules, modalities and procedures on baseline-setting, additionality and MRV aiming to foster sustainable development, incentivise participation of public and private actors. Moreover, Art. 6 established design principles such as environmental integrity, additionality of action, the promotion of sustainable development as well as robust accounting and transparency (see chapter 3.1).

2.2. The integration of HFCs into the Montreal Protocol

Under the Montreal Protocol, the worldwide phase-out of CFCs has been achieved in 2010. Developed countries will have to phase-out HCFCs, the first generation of CFC replacements, until 2020 and developing countries until 2030 (UNEP 2018c). Until 2030 for developed countries and 2040 for developing countries, respectively 0.5% and 2.5% of base year consumption of HCFC is allowed for servicing refrigeration and air conditioning equipment (UNEP nD a). With the adoption of the Kigali Amendment (KA) on October 15, 2016 at the 28th Meeting of the Parties to the MP (MOP), HFCs -used so far as substitute refrigerants for HCFCs- will be phased down to 80-85% of the baseline values established for developed and developing countries by the late 2040s (UNEP nD b, Roberts 2017). It is important to highlight that the development of detailed rules for KA implementation is taking place in parallel to the development of detailed rules for the PA under the UNFCCC.

A key challenge in the negotiations that led to the KA was that HFCs themselves have no or only little ODP, while contributing to climate change which is regulated under the UNFCCC. Since 2009, proposals for an inclusion on HFCs were submitted annually by Mexico, Canada and US on the one side as well as Micronesia with changing partners on the other hand. This unusual coalition was held together by an interest of US private sector companies to sell technologies replacing HFCs (Nayak 2018) and the small island states wanting to drive GHG mitigation. However, many countries, including India and China and the Gulf Cooperation Council, were reluctant to agree to HFC phase-down with regards to the uncertainties in alternatives and costs. They argued that the reduction of HFCs should be dealt with exclusively under UNFCCC. In 2015, the EU proposal of a phase down schedule differentiated according to country groups was a key game-changer in negotiations of the amendment and softened the opposition. India, having been lead opponent to the HFC amendment, filed its own proposal in 2016, pushing for longer timelines and greater financial support to Article 5 countries. Negotiations succeeded after an agreement was reached to better take into account the challenges associated with phasing down HFCs (Roberts 2017).

The KA will enter into force on January 1, 2019 as the required threshold of 20 ratifications has been met on November 17, 2017 (UNEP 2018b), standing at 56 ratifications as of October 5, 2018 (UNEP Ozone Secretariat 2018). So far, at least 95 countries have indicated their support for the amendment including a coalition of Island states, the EU, India, US, Canada and Mexico as well as the 54 members of the African Group (IGSD 2018).

2.2.1. HFC phase-down mandated by the Kigali Amendment

The KA extended the list of controlled substances under the MP by 18 HFCs and establishes a phase-down regime for their production and consumption (the latter being defined as production + imports – exports). The reason for not introducing a complete phase-out objective is the current lack of technically and economically feasible alternatives for certain subsectors of negotiations (UNEP nD a). The HFCs included in the MP are listed in Annex F and divided in two groups: 17 HFCs belong to Group I, while HFC-23 is listed under "Group II" because being a by-product of the manufacturing process of other gases, mainly HCFC-22 (UNEP 2016a, see Annex A).

For HFC-23 (referred to in the KA as Annex-F Group II substance), specific regulations are being introduced. According to Article 2J.6, country Parties producing HCFCs or HFCs must ensure from January 1, 2020 onwards that emissions of HFC-23 generated in each production facility manufacturing HCFCs or HFCs are destroyed to the extent practicable using technology approved by the Parties (UNEP 2016b). A first catalogue of destruction technologies for HFC-23 has been adopted at the 30th Meeting of the Parties to the Montreal Protocol (MOP) in its Decision XXX/6 (UNEP 2018a)[4]. Given the fact that there are technologies available to destroy HFC-23 and tested under the UNFCCC in the context of the CDM, destruction of HFC-23 will become mandatory as practicable to an extent of 99.99%. However, this leaves a glaring gap until 2020 where emissions of HCFC-22 plants built after 2003 could theoretically continue unabated. Fang et al. (2014) estimated that these emissions could exceed 100 million t CO_2e/year. UNEP (2017b) specifies four plants worldwide without destruction equipment, one each in China, Mexico, North Korea and Venezuela and finds that 45% of Chinese HFC-23 generated in 2015 was emitted, i.e. 71.6 million t CO_2e, and 1.2 million t in Argentina, North Korea and Venezuela. India has mandated HFC-23 destruction at all its plants, China was planning to do so by 2017.

Under the phase-down regime applicable to the 17 HFCs included in Annex F Group I, quantities allowed for production and consumption will be calculated no longer in metric tonnes but in CO_2e, enabling countries to prioritize the reduction of HFCs according to their GWP (UNEP nD a). Therefore, GWP values have been added to the Protocol text for HFCs and selected HCFCs and HFCs (UNEP nD b). Baseline values for HFC production and consumption consider the baselines already established for HCFC production and consumption to take into account that HCFCs are still being produced and consumed during base years for which a HFC baseline was established (UNEP nD a).

[4] So far this includes: gaseous/fume oxidation; liquid injection incineration; reactor cracking; rotary kiln incineration; argon plasma arc; nitrogen plasma arc; chemical reaction with H_2 and CO_2; superheated steam reactor. The TEAP has been requested to assess further technologies, in particular HFC-23 destruction by cement kilns (Decision XXX/6).

The amendment contains two central incentives for ratification: First, Parties agreed to introduce mandatory national HFC import and export licensing systems by January 1, 2019, covering all virgin, recovered, recycled and reclaimed HFCs and mixtures containing them. Secondly, on January 1, 2033 a ban on trade with non-Parties will enter into force provided that at least 70 countries have ratified the Amendment by then (UNEP nD a; Roberts 2017).

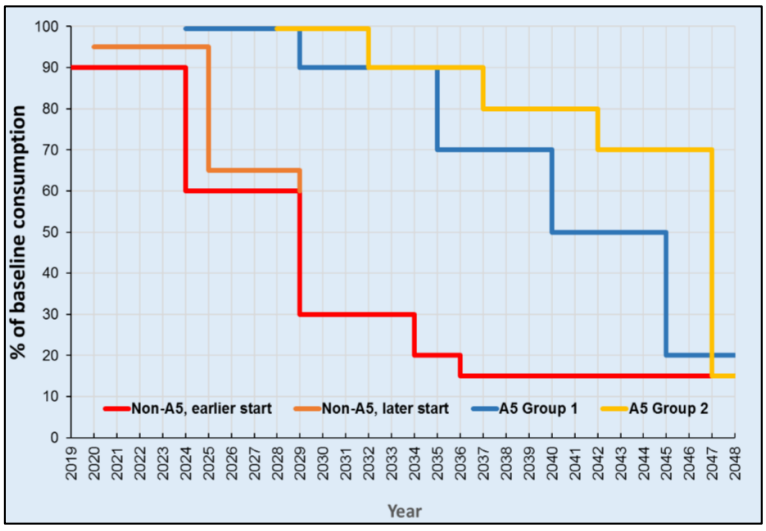
The phase down schedule as well as the baseline calculation is differentiated among country groups. The MP relies as the UNFCCC on the principle of common but differentiated responsibilities and gives developing countries under Article 5 of the MP more flexibility and time to comply with the obligations.

Article 5 countries have been divided into two groups, with the majority of developing countries belonging to the first, freezing HFC consumption and production in 2024 and mitigating from 2029 onwards. A smaller second group with higher ambient temperatures (HAT) benefits from later baseline years, freeze date and phase-down steps (UNEP nD b). The countries having opted for this exemption schedule have in return committed to a more stringent phase down of 85% compared to their baseline (Roberts 2017). Also, four to five years before 2028, the Technology and Economic Assessment Panel (TEAP) serving the MP, will hold a technology review to consider compliance deferral of 2 years from the freeze date of Article 5 Group 2 to address growth in relevant sectors above a certain threshold (UNEP nD b).

Non-Article 5 countries (developed countries) do not have a « freeze » date, but directly reduction targets from 2019 onwards (UNEP nD b). Some non-Article 5 countries have a different formulation for the calculation of baseline and other initial phase-down steps, in order to grant them more time to develop alternatives and the infrastructure needed to implement the phase-down (Roberts 2017).

This gives a quadripartite phase-down schedule for the overall implementation span of 2019 to 2047:

Figure 1: Kigali Amendment HFC phase-down schedules



Source: UNEP (nD c), p. 2

Apart from the reduction steps, developing countries also have different baseline years compared to developed countries. The developed countries baseline is calculated from the past average consumption and production of HFCs between 2011 and 2013. Baseline emissions from developing countries however will be calculated on the basis of future average consumption and production in 2020-2022 or 2024-2026, as it has been common practice to introduce future consumption level as baselines for Article 5 countries under the MP. This implies that the expected significant growth of HFC emissions in the coming years will be tolerated under the KA.

Table 1: Phase-down schedules and baselines set up in the Kigali Amendment

	Art.5 G1	Art.5 G2[5]	Non-Art.5 G1	Non-Art.5 G2
Baseline years	2020-2022	2024-2026	2011-2013	2011-2013
Baseline calculation	Average production/ consumption of HFCs in 2020-2022	Average production/ consumption of HFCs in 2024-2026	Average production/ consumption of HFCs in 2011-2013	
	Plus 65% of HCFC baseline		**Plus** 15% of HCFC baseline	**Plus** 25% of HCFC baseline
Freeze year	2024	2028	-	-
Reduction Step1	2029 - 10%	2032 - 10%	2019 - 10%	2020 – 5%
Reduction Step2	2035 – 30%	2037 – 20%	2024 - 40%	2025 – 35%
Reduction Step3	2040 – 50%	2042 – 30%	2029 – 70%	
Reduction Step4			2034 – 80%	
Plateau	2045 – 80%	2047 – 85%	2036 – 85%	

Source: authors' own elaboration based on UNEP (nD a; nD b)

For certain equipment[6] where current alternatives to HFCs are proven not to be energy efficient at HAT conditions, a further exemption for HAT countries has been included[7]. The idea is to prevent a transition to technologies that comply with the agreement but do not represent a net benefit for climate. Countries opting for this exemption can further delay their freeze date and initial control obligations for four years. The TEAP will periodically review if the exemption must be extended further or if suitable alternatives for these countries have been commercialized (UNEP nD a; UNEP 2016b; Roberts 2017).

Not yet inside the scope of the MP is the collection and destruction of HFC banks[8], a major source of GHG emissions. In 2002, TEAP and IPCC estimated that direct emissions from HFC banks would

[5] This group of countries comprises: Bahrain, India, Iran, Iraq, Kuwait Oman, Pakistan, Qatar, Saudi Arabia and the United Arab Emirates

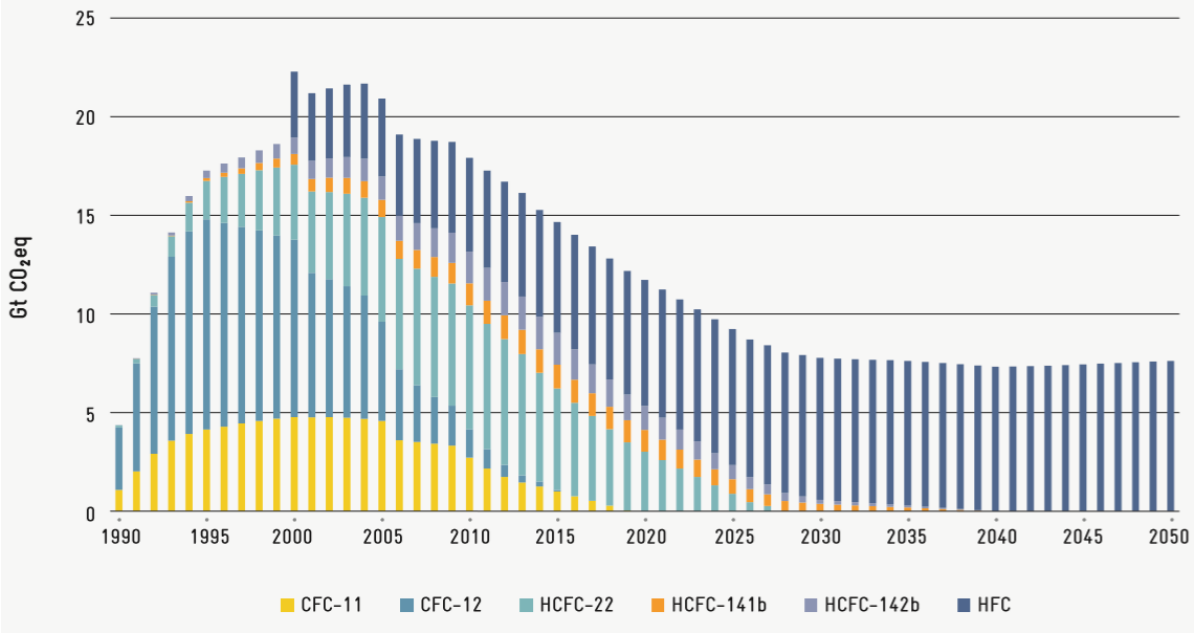
[6] The HAT exemption applies to multi-split air conditioners (commercial and residential); split ducted air conditioners (residential and commercial) as well as ducted commercial packaged (self-contained) air-conditioners (UNEP nD a).

[7] The exemption applies to: Algeria, Bahrain, Benin, Burkina Faso, Central African Republic, Chad, Côte d'Ivoire, Djibouti, Egypt, Eritrea, Gambia, Ghana, Guinea, Guinea-Bissau, Iran, Iraq, Jordan, Kuwait, Libya, Mali, Mauritania, Niger, Nigeria, Oman, Pakistan, Qatar, Saudi Arabia, Senegal, Sudan, Syria, Togo, Tunisia, Turkmenistan and United Arab Emirates (UNEP nD a).

[8] Quantities of HFCs already produced or in use of which a portion is likely to eventually be emitted to the atmosphere (UNEP 2017).

reach 2.3 Gt CO_2e per year by 2015. ODS banks are in decline, in line with the phase-out schedules of the Montreal Protocol, but HFC banks will increase due to their current use as HCFC substitutes (GIZ 2018b).

Figure 2: Global ODS and HFC banks, in Gt CO_2e



Source: GIZ (2018b), p. 7

In 2018, there will be a report from the TEAP on various scenarios concerning the size of ODS and HFC banks and potential mitigation of banks. A working group has been established to develop models for the banks' destruction scenarios (Roberts 2017).

Over the entire period 2018-2050, compliance with the KA is expected to remove 39 GtCO_2e or 61% of global HFC emissions, while the technical abatement potential is estimated at 85% (Höglund-Isaakson et al. 2017). According to IGSD, a fast phase-down of HFCs in all countries from 2020 onwards could prevent 100-200 Gt of CO_2 emissions, including avoidance of HFC banks (2018).

2.2.2. Financial instruments under the Montreal Protocol

Depending on the rate of technological development and the extent to which planned electricity savings can be realized, the global cost of KA compliance is estimated to range anywhere between a net cost-saving of 240 billion € to a net cost of 350 billion € for the entire period. Meanwhile, the implementing costs will vary widely between the different country groups. In any scenario HAT Art.5 countries are expected to face a significant increase in abatement costs after 2040 due to the high demand for cooling services in mobile and commercial air conditioning and limited opportunities for energy efficiency improvements (Höglund-Isaakson et al. 2017).

HFC mitigation costs will have to be alleviated by the MLF, established to pay the incremental costs incurred by developing countries to meet their obligations under the MP. These incremental costs include costs associated with the supply of substitute chemicals, conversion of existing production facilities, capital costs of equipment, training, premature retirement of equipment and associated lost profits, technical assistance as well as research and development. The calculation of incremental costs is thereby very similar to the determination of "additionality" undertaken in the context of the UNFCCC to determine if an activity is eligible for international market mechanisms or international climate finance (see Chapter 3).

The MLF is funded by contributions from approximately 40 developed country Parties and directed by the Executive Committee (ExCom) with equal representation of developed and developing country Parties to ensure fair distribution of funding (Roberts 2017). Funding from MLF is generally provided in the form of grants and delivered through four international implementing agencies UNEP, UNDP, UNIDO and the World Bank. Up to 20% of developed country Party contributions to the MLF can be implemented by bilateral agencies (Decision II/8, in UNEP 2018c).

The MLF will be tasked with supporting developing countries in complying with the obligations under the KA, by providing incremental financing for transitions in technologies and in-country infrastructure, facilitating technology transfer and capacity building, but also by funding demonstration and pilot projects for new alternatives (Roberts 2017). In November 2017, the MLF has been replenished for the 10th time for the period 2018-2020. 540 million USD were granted, however mainly to continue work on HCFC phase-out through implementation of HCFC phase-out management plans (HPMPs). Interestingly and in sharp contrast to the position and associated budget cuts of the Trump Administration under UNFCCC, the USA did allocate 31 million USD to the MLF in the new 2018 budget, only one million less than initially pledged. White House energy adviser George David Banks is a strong supporter of the ozone treaty "given the importance of the MP to US commercial interests, the US need a financially healthy multilateral fund". This shows the continued interest of the new US administration in the successful implementation of the MP due to its own economic interests, thereby highlighting the importance of political economy considerations as a crucial factor (Chemnick 2018).

Beyond the funding for the MLF, funding for initial enabling activities of HFC phase-down will be supported by additional voluntary contributions from a group of donor countries of 25 million USD and include:

- Support for early Kigali ratification, work on institutional arrangements and data reporting on HFC production and consumption.
- Funding for a limited number of HFC phase-down projects to determine typical costs of HFC conversions and support development of future cost and funding guidelines
- Provision of limited resources for the preparation of HFC-23 demonstration projects, showing cost-effective ways to destroy HFC-23 (GIZ 2018a).

As a complementary funding source, a group of 17 foundations and philanthropists has funded the Kigali Cooling Efficiency Program (K-CEP) with 51million USD to support Art.5 countries in implementing the KA with a focus on energy efficiency through capacity building, accelerated implementation of policies and standards, finance for implementation of these national plans and support for small-scale cooling solutions (K-CEP 2018).

Apart from initial enabling activities, substantial funding for HFC phase down under the MLF will be provided only after 2020 and more intensively after 2024 in a stepwise process (GIZ 2018a). To orient this funding, the ExCom has been tasked to develop "guidelines for financing the phase-down of HFC consumption and production, including cost-effectiveness thresholds" until 2018. The guidelines must incorporate the principle that Article 5 countries will have flexibility to prioritize HFCs, define sectors, select technologies and alternatives and elaborate and implement their strategies to meet agreed HFC obligations, based on their specific needs and national circumstances, following a country-driven approach (UNEP 2016b). The MOP already formulated a framework for identification of general funding principles to the MLF, including mandatory and optional funding topics and activities (GIZ 2018a):

Table 2: Overview of eligibility for funding under the MFL

Selected activities that are eligible for MLF funding, if required for compliance with the HFC phase down	Selected activities that are not directly required for compliance, but funded on a case by case basis	Selected activities that are not required for compliance and generally not eligible for funding
- HFC manufacturing conversion - Compensation for HFC production shut down - Capacity building and training programmes for manufacturing and servicing for replacement of HFC-equipment and products - Training of customs to control import and exports - Development of preparatory surveys and projects - Development of national management plans for controlled substances - Institutional strengthening - Management strategy for disposal of controlled substances	- Demonstration of HFC replacements in the end-user sector - In cases where HFC conversion would result in lower energy efficiency: additional, cost-effective measures to keep the same or slightly better efficiency level - Development of national management strategies for disposal and destruction of HFCs	- Energy efficiency, if not essential for HFC conversion - Costs of disposal or destruction of HFCs - Sector inventories on energy consumption and related emissions - Development on building codes and minimum energy performance standards - Institution building for managing energy efficiency in buildings and the appliance sector

Source: GIZ (2018), p.12

Also to be included in the list of eligible costs for funding are "costs of reducing emissions of HFC-23 […] by reducing its emission rate in the process, destroying it from the off-gas or by collecting and converting it to other environmentally safe chemicals" (UNEP 2016b, Art.15(b,8)).

The development of cost guidelines is to be seen as an opportunity for the MLF to widen its scope and support to the extent possible R&D activities in addition to or through financing of demonstration projects. Still left to negotiations are:

- overall level of incremental operation costs (IOCs) and incremental capital costs (ICCs)
- incremental costs for patents, the safety of flammable and toxic substances, and R&D
- the support for energy efficiency, HFC disposal or exemptions for HAT countries

(UNIDO 2017).

The finalization of the funding guidelines by the ExCom has been a key sticking point of negotiations at MOP30 with Article 5 countries concerned by the costs of HFC phase-down. Whereas the US underlined its position that funding guidelines should be finalized quickly by the ExCom, India insisted successfully on mandating the ExCom to present the guidelines for input by parties before finalization to ensure they adequately reflect the needs of Article 5 countries (IISD 2018).

The MLF will also provide funding to pilot/demonstration projects and for energy efficiency measures through funding of policy and regulations, capacity building and best practices, which represents a significant change in strategy (IISD 2018). So far, the MLF has focused on identifying the most cost-effective replacement for an ODS and then reimbursed the cost for transition. This excluded funding to maintain or enhance energy efficiency. In some cases, energy efficiency savings were even deemed to be a windfall and deducted from the incremental costs paid by the MLF. With the mandate given to the MLF in decision XXVIII/2 (UNEP 2016b), the fund now will have to incorporate the GWP of substitutes and energy efficiency into its calculations and address a new array of low-GWP, zero-GWP and not-in-kind alternatives. In this context, a key issue to resolve is whether energy efficiency incremental costs will be paid when efficiency is maintained, improved slightly or maximized. At MOP30, the African Group presented a proposal related to market regulation to ensure effective energy transitions. As many parties considered this outside of the mandate of the Protocol, discussions shifted to calls for broader discussions around co-financing sources for Article 5 countries (IISD 2018).

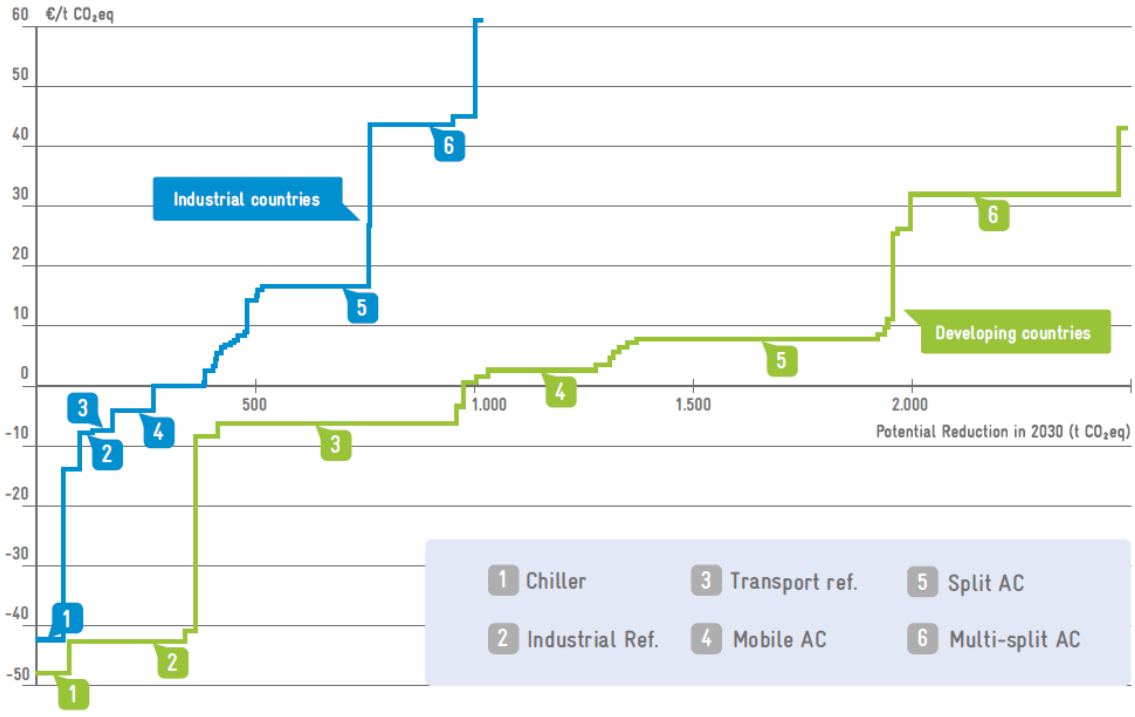
Also, incremental costs for HFC alternatives still have to be determined. Before the KA, the MLF has paid for simple modifications to manufacturing plants to adapt them to the substitute refrigerants. Now there is no obvious alternative refrigerant, but many different alternatives for specific industrial sectors and specific types of equipment. Many of these alternatives are also no longer fluorinated gases, but new refrigerants and technologies and not-in-kind substitutes[9] (Roberts 2017). Clearly, MLF resources will not be sufficient to allow developing countries to leapfrog from HCFC-using equipment to low-GWP alternatives and prepare for a fast HFC-phase-down (GIZ 2018a).

Simultaneously, the MLF will have to consider in its funding guidelines if it will cover the costs for transitions to HFCs with lower GWP or hydrofluoroolefins (HFOs) and HFC/HFO blends that could be used as drop-in-replacements. These technical solutions promise lower transaction costs and quick savings in CO_2e emissions, but often suffer from poor energy efficiency and will be subject to a later,

[9] Not-in-kind substitutes include alternative cooling systems other than vapor compression cooling systems such as district cooling systems (Roberts 2017).

second phase-down adjustment (Roberts 2017). Financing a direct switch to natural refrigerants (CO_2, hydrocarbons, ammonia, air, water) comes with higher upfront costs but promises a long-term solution not affected by phase- down schedules or regulation. Natural refrigerants offer a superior Life Cycle Climate Performance (LCCP), taking into account all emissions related to the life cycle of the products as compared to HFCs in many applications. These options might be costly, but would be eligible for climate finance as achieving the transformational impact/ paradigm shift required in funding principles of financial mechanisms such as the Global Environmental Facility (GEF), the Green Climate Fund (GCF) or the NAMA Facility. Plus, widespread use of hydrocarbons (HC) in domestic and light commercial refrigeration equipment, or use of CO_2 in commercial refrigeration, have already led to a level playing field in terms of the price of the equipment. By 2020, 75% of all new domestic refrigerators is expected to use R600a (isobutane) or R290 (propane) (UNIDO 2017). The investment and operating cost structures of these new technologies may vary, however, between countries, as especially developing countries face higher barriers in access to capital markets or technical innovations. At MOP30, the TEAP has been tasked to prepare a report on the cost and availability of low-GWP technologies and equipment that maintain or even enhance energy efficiency. The report should cover various RACHP sectors and in particular, domestic air-conditioning and commercial refrigeration taking into account geographical regions, including countries with high ambient temperature (HAT) conditions. Also the ExCom has been tasked to increase funding to low-volume consuming countries, where an increase in consumption is to be expected with economic development (IISD 2018).

Figure 3: Marginal abatement cost curve in the RACF sector



Source: GIZ (2018a), p. 10

The graph above shows the Marginal Abatement Cost Curve (MACC) in the RACF sector, where the cost per tCO_{2e} of each technology improvement, both in efficiency and change of refrigerant, is showed.

Larger units like chillers, industrial and transport refrigeration have negative costs and are thus profitable, while mobile AC and split AC can achieve a large mitigation at low positive marginal cost, which would require external support. Due to high marginal costs for industrial countries it would be attractive to invest in developing countries to generate emission credits from the market.

A discussion that cannot be reflected in detail in the context of this paper, but is of imminent importance, is the need for reviewing and adapting safety standards and building codes with regard to natural refrigerants. Standards applicable to low-GWP alternatives are often missing or outdated and a significant barrier to the development and market penetration of innovative technologies (GIZ 2016, Roberts 2017)[10]. As these standards are often set in cooperation with industrial associations, the political economy component should not be neglected, as there might be conflicting interests influencing the standard setting process. HFC mitigation strategies and actions must include significant resources to modernize existing standards based on robust data and evaluations performed by independent actors.

3. Potential linkages and synergies between UNFCCC and MP

The KA focuses in its regulation on the supply side of the refrigerant market and covers the incremental costs associated with meeting obligations in Article 5 countries. However, the implementation of the KA is not sufficient to achieve a rapid transition to lower-GWP refrigerants, needed to ensure maximum emission avoidance and long-term transformational change. This is also being acknowledged by the ongoing negotiations under the Montreal Protocol, where Article 5 countries call for broader discussions on opportunities for co-financing of energy efficiency measures and KA implementation (IISD 2018). Synergies with the UNFCCC should be enhanced in order to incentivize early bottom-up action by Parties going beyond compliance with the KA.

The KA formally addresses its linkage to the UNFCCC in Article III: “This Amendment is not intended to have the effect of excepting hydrofluorocarbons from the scope of the commitments contained in Articles 4 and 12 of the United Nations Framework Convention on Climate Change or in Articles 2,5,7 and 10 of its Kyoto Protocol” (UNEP 2016a). This makes it clear that HFCs will continue to be GHGs covered, monitored and mitigated under the UNFCCC. However, it says little on the institutional interplay that needs to be defined when the detailed rules for both agreements are developed. In that process perverse incentives for setting low mitigation scenarios or not ratifying the Kigali Amendment need to be avoided while synergies should be enhanced through the use of market mechanisms to enhance HFC mitigation ambition beyond countries’ phase-down schedules.

[10] An overview of existing standards for refrigeration, air conditioning, and heat pump systems and appliances has been published by the TEAP in June 2018 and is accessible via: http://conf.montreal-protocol.org/meeting/oewg/oewg-40/presession/backgroundnote/safety-standards_tabular-overview_background-note.pdf (accessed October 23, 2018)

3.1. Impact of the KA on the scope of UNFCCC- Art. 6 activities

Activities advancing the mitigation of HFCs under the UNFCCC could be implemented under three different mechanisms enshrined in Article 6 of the PA (see section 2.1.2). Both market-based approaches established under Art. 6.2 and 6.4 would be an avenue for financing HFC mitigation through carbon credit revenues.

The work plan for non-market approaches (NMA) under Art. 6.8 enables consideration of results-based financing to finance a direct leapfrogging to low-GWP alternatives for refrigerants needing high upfront financing. In this case, CDM or Article 6.4 baseline methodologies and MRV systems could be used to demonstrate the mitigation impact achieved while the credits generated would be voluntarily cancelled by the financing institution/donor country. Generally, multi- and bilateral climate finance for covering the high upfront costs of transitioning to low-GWP production in RACF sectors could be blended with Article 6.2 and 6.4 mechanisms to cover running operation costs. For example, market mechanisms could focus on the options with low marginal abatement costs while climate finance could harness the higher cost options. Ideally, a landscape of "integrated climate finance" would blend different financial sources and instruments for HFC reduction going far beyond the limited funding resources of the MLF.

Below, this paper will focus on the implications of the KA for CAs and the SDM in light of the principles underpinning these mechanisms.

3.2. Applying key Article 6 principles to HFC mitigation activities

Principles for the PA market mechanisms are enshrined in Article 6 of the Paris Agreement as well as in the accompanying decision to its inclusion 1/CP.21 (UNFCCC 2015). Their operationalization in the different approaches is still subject to the ongoing negotiations, but they are associated with the following implications:

- *Environmental integrity*, meaning that the issuance and transfer of credits should not result in an overall increase of aggregate GHG emissions (Schneider & La Hoz Theuer 2018). Preserving environmental integrity needs a combination of approaches and perverse incentives perpetuating certain high GHG technologies need to be avoided; these are discussed below. The overarching principle gives rise to two "sub-principles":
    - *Robust accounting*, issuance and transfer of credits but be tracked and accounted against GHG inventories and NDC targets through "corresponding adjustments" after transfer so as to avoid double counting of emission reductions (jeopardizing environmental integrity)
    - *Additionality*, meaning that credits should only be issued for activities that would not have occurred in the absence of the mechanisms and that contribute to an increase in ambition (Michaelowa and Butzengeiger 2017). Not ensuring additionality in funding or crediting would essentially mean wasting the scarce funds available for mitigation and adaptation. Ambitious mitigation targets going beyond business-as-usual are

crucial to ensure additionality of mitigation. If this cannot be ensured, stringent baselines and additionality tests are required. Under the KP mechanisms, additionality requirements first have been enhanced as a reaction on media and NGO criticism of CDM and JI (see Wara 2007), but interpreted more leniently after the collapse of CER markets to keep transaction costs in check (Michaelowa and Butzengeiger 2017).

- *Increasing of mitigation ambition* in line with the ratcheting-up approach of the PA in order to contribute to the realization of the overall temperature goal of the agreement.
- *Promotion of sustainable development:* contributions to sustainable development co-benefits and impacts of activities in particular on the SDGs must be considered and reported on.

We now discuss how these principles can be operationalized in the context of HFC reduction activities under Art. 6 taking into account KA phase-down schedules and related rules.

3.2.1. HFC accounting and inclusion in NDC

Robust accounting enables Parties to track the overall progress made in achieving national as well as international targets and evaluate the impact of their actions on global GHG emissions. Transfers of HFC- reduction activity-generated ITMOs must be adequately reflected in NDCs and related GHG inventories and/or registries. The great diversity of NDCs regarding mitigation targets, coverage of sectors and gases and metrics used is a key challenge (La Hoz Theuer and Schneider 2018). Accounting for HFC-projects can be facilitated through linking it closely to the implementation of the national HFC management plans that will be developed under the KA. The KA will impose common reporting and metrics which should facilitate not only reporting and accounting for host and buyer countries, but also enable inclusion of HFC emissions and mitigation plans in NDC. If HFCs are included in the NDC baseline and targets of a Party, credits will have a higher quality and be more likely to attract buyers under Art.6.2. Emission sources and sectors not covered under a NDC should not be eligible in general for Art. 6.2 in order to preserve environmental integrity through corresponding adjustments to NDC targets (Michaelowa and Butzengeiger 2017).

Preconditions for robust accounting include:

- GHG inventories with regularly updated and robust data, on which basis NDCs are formulated and revised
- Stringent procedures for monitoring, reporting and verification of emission reductions
- Registries tracking the transfer of ITMOs
- Corresponding adjustments that reflect ITMO transfers on the basis of GHG inventories or NDC targets

Here, clear synergies can be exploited between KA and PA, as the KA demands Parties to introduce:

- An MRV system for production, imports and exports of HFCs measured in CO_2e to report the quantities annually to the Montreal Protocol Secretariat

- The establishment of a system to license the production and the import of HFCs and the allocation of quota to companies for production and import of HFCs

An administrative verification system at the customs authorities to ensure that only accredited companies import HFCs (UNEP nD d).

3.2.2. Including HFC phase-down under KA in PA NDC baseline

Environmental integrity can only be preserved if NDCs do not generate “hot air” i.e. NDC targets being less stringent than business-as-usual (BAU) emissions scenarios. For example, in a country currently having emissions of 70 Mt CO_2 an NDC aiming at a reduction of 10 Mt CO_2 from a 100 Mt CO_2 baseline generates hot air if the real business as usual emissions would be 80 Mt CO_2. The amount of hot air in NDC targets is estimated currently to be similar in magnitude as total mitigation by countries with NDC targets more stringent than BAU (La Hoz Theuer et al. 2017). This means that the ambition of some countries is being counterbalanced by the lack of ambition of the others. If credits from countries with NDC targets generating “hot air” are transferred, not only will this lead to an overall increase in emissions, but also provide a perverse incentive to Parties to set NDCs at less ambitious levels so as to be able to credit more. Hot air transfers can only be prevented through stringent additionality testing (Michaelowa and Butzengeiger 2017). With regards to HFC-mitigation projects, the KA phase-down schedule should define the NDC baseline. The annual HFC data under the KA can be used as a robust basis for baseline development and mitigation targets. The allocation of quota and the enforcement of an HFC “cap” in the country can be easily used to monitor and verify the emission reductions achieved. Furthermore, setting up the reporting procedures in Article 5 countries will be eligible for funding by the MLF and could represent a good example for blending ODS/climate finance and market mechanisms.

3.2.3. Regularly update HFC baselines to take into account technical innovations

Crediting according to BAU baselines for a long time period is not sufficient to guarantee the environmental integrity of the mechanism. BAU forecasts have often proven remarkably off the mark especially if they cover long time periods. Unforeseen changes in technology or the structure of a national economy need to be reflected adequately. A potential solution that enables longer crediting periods would be either revising BAU baselines frequently or to adopt “dynamic baselines”, calculated ex-ante but where the parameters entering the calculation are quantified ex-post (Michaelowa and Butzengeiger 2017). In general, baselines for HFC-projects should be linked to the regular TEAP assessments of economically viable alternatives for refrigerants to the market and be revised accordingly. Under Art.6.4, baselines will be approved by the Supervisory Board (SB), under Art.6.2 a greater leeway for Parties in adopting baselines could be agreed.

3.2.4. Develop sectoral or policy-related HFC mitigation baselines to allow for upscaled crediting approaches

Crediting for sectoral approaches based on the introduction of policy instruments can be an opportunity to achieve significant emission reductions. When upscaling crediting beyond projects and programmes, the formulation of baselines at a sectoral level or related to a policy instrument is a key challenge. Upscaled crediting in the context of the PA requires translating the HFC mitigation into a concrete mitigation pathway and a specification of how different sources for HFC emissions are expected to contribute to this pathway (PMR 2017). Policy instruments that would be eligible under Article 6 mechanisms are:

- Regulatory mitigation policy instruments that require large financial interventions, for instance investments in technologies with a higher efficiency and payback periods of more than five years.
- Carbon pricing policies as soon as the carbon price exceeds a threshold and is likely to incentivize emission reductions, for instance in the context of sectoral trading mechanisms or carbon taxes. Also eligible would be an ETS allocating allowances below a BAU scenario. A reasonable price threshold for developing countries would be of 10€/tCO_2e.
- Financial incentive schemes based on a case-by-case additionality assessment (Michaelowa and Butzengeiger 2017).

3.2.5. Ensuring additionality of activities

Additionality is key not only to environmental integrity but also to ensure market credibility and viability. The following approaches are suggested to ensure additionality of HFC mitigation under Art. 6:

Harmonizing additionality tests with funding guidelines under the MLF: In principle, additionality testing could be similar to the MLF principle of covering “incremental costs” associated with capital investments, operation but also patents and research and development. Depending on the scope of the cost guidelines for the MLF as well as the Art. 6 rulebook, additionality under Art. 6 may go beyond the detail of the incremental cost rule of the MLF, as it can better take into account the specific cost structures (investments and operating costs) of countries, their access to capital markets (risk premiums) and learning curves and associated cost depreciation of developing innovative technologies. The Art. 6 additionality tests ideally would also take into account the long-term climate benefits of switching to low-GWP refrigerants instead of opting for seemingly more cost-efficient drop-in solutions. There could be even eligibility criteria introduced in form of positive lists of HFC substitutes that yield these long-term benefits, also to stimulate innovation in the development of low-GWP solutions. Meanwhile, Article 6 additionality tests should be synchronized as far as possible with MLF and TEAP assessments of available technology and investment and operating costs. To lower transaction costs for developing countries, standardized additionality tests in the form of positive lists or automatic additionality for projects and programmes beyond a certain size – i.e. covering entire fleets

of appliances - could be introduced, as it has been the case under the CDM (Michaelowa and Butzengeiger 2017).

Include the KA phase-down in the unconditional part of NDCs: In a stringent operationalization of the principle in the SDM, non-conditional targets in NDC would not be deemed additional and thus eligible for crediting. In light of the KA, all legislative and regulatory steps necessary to comply with its obligations and therefore eligible for MLF funding in Art.5 countries should be translated in the NDC as an unconditional target. Simultaneously the labelling of “conditional” targets going beyond the KA should be a necessary, but not sufficient condition for additionality, as perverse incentives should be avoided to declare a maximum of action to be conditional. The opportunity to sell credits for any activity going beyond the KA would provide incentives for early action and therefore higher ambition. Simultaneously, HFC mitigation under the unconditional part of the NDC could be eligible for climate finance if demonstrating significant positive costs and a long-term so-called transformational impact on the demand or production structure of the country. Crediting could then be applied for all further enhancing of ambition in an approach of instruments blending.

3.2.6. Eliminating perverse incentives that might reduce ambition

Baselines need to be based on the KA phase-down schedule regardless of a government’s ratification of the KA. This could prevent a perverse incentive not to ratify the KA in order to be able to generate credits for the full amount of reductions achieved. Alternatively, having ratified the KA could be made a general eligibility criterion for participating in Art. 6 mechanisms in order to prevent perverse incentives.

Furthermore, the SDM could restrict crediting of non-covered sectors under the condition of committing of their later inclusion into the NDC. This would provide incentives for HFC coverage in NDCs and allow for the building of MRV capacities at the same time as implementing early activities and corresponding adjustments would follow ex-post.

It is also important that technology lock-in effects are prevented. Without safeguards, market participants would favor mitigation actions that are cost-effective in the short and medium term (La Hoz Theuer and Schneider 2018). Art. 6 baselines and crediting periods should be defined in a way promoting the switch to natural refrigerants and low-GWP solutions rather than financing drop-in solutions that do not present the optimal LCCP.

3.2.7. Raising ambition through achieving a net mitigation impact

The SDM aims to achieve a net mitigation impact. While it is not clear yet if such a net impact will be operationalized through overly conservative baselines, or shorter crediting periods with limited renewal potential, discount factors to ITMOs transferred on the basis of HFC emissions seem to be the most feasible option in this context. Discount factors have already been applied in CDM methodologies, regarding the high number of credits the mitigation of HFC with high GWP can generate. Moreover, a

permanent cancellation of carbon credits in registries in exchange for climate finance can also contribute to net mitigation effects.

3.2.8. Raising ambition to promote early action and influencing KA baseline year emissions

Art. 6 activities that go beyond or start earlier than the KA phase-down schedule foresees are to be deemed additional. Simultaneously, their mitigation impact in the baseline years of Article 5 countries should be captured in the KA baseline calculation in order to promote higher ambition under the KA. In the Kyoto era, CDM activities were excluded from baseline calculations in CDM methodologies. In order to ensure integrity and ambition, Article 6 activities of the PA should be taken into account in baseline setting for HFC emissions under the KA. Art. 6 pilots are expected to be developed in the upcoming years (2019-2021) and upscaled in the run-up to the first global stocktake of progress realized under the PA in 2023. Therefore, Art. 6 activities are likely to take full mitigation effect in the course of HFC baseline years under the KA.

3.2.9. Destruction of HFC banks

The more appliances using HFCs are installed, the higher the volume of HFCs sealed in these appliances ("HFC banks") and released after their end-of-life (on average after 20 years) and need to be disposed properly to avoid leakage of emissions (see section 2.2.1, GIZ 2018b). Any early phase-out of HFCs going beyond the KA thus would a direct impact on the reduction of HFC banks. For instance, if HFCs were to be phased out by 2020, 50 Gt CO_2e trapped in HFC banks could be avoided (Velders et al. 2014). Given that the banks are not covered under the KA, activities to collect and eliminate existing HFC banks stockpiled from industrial and consumer appliances through regulatory and incentive measures, e.g. take-back obligations for manufacturers, should be fully creditable under Art. 6. As they are not likely under business-as-usual, they could be automatically deemed additional.

3.2.10. Promoting wider sustainable development linked to cooling

Sustainable development is seen as a national prerogative by a large number of Parties to the UNFCCC. However, as its promotion is enshrined in Art. 6 of the PA, there will be at least some minimal guidance for reporting and reviewing of sustainable development benefits. Furthermore, and as we already witness on the voluntary carbon market (VCM), credits with high sustainable development impacts attract higher prices on the market. HFC projects can showcase their high impact on the realization of the Sustainable Development Goals (SDGs), as cooling affects areas such as poverty reduction, the eradication of hunger and food security, economic growth and better infrastructure, health, quality education, gender equality, sustainable production and consumption as well as the access to affordable and clean energy (UNIDO 2017). Most urgent is decoupling the rising demand for air conditioners in HAT countries, where heat already today plays a larger role in cardiovascular

mortality (WRI & Oxfam 2018). Moreover, other benefits regarding local pollution related to secondary products of HFC decay need to be taken into account.

Following the discussion about how HFC mitigation activities can generally fulfil the criteria under Art. 6., we discuss eligibility of specific activities.

3.3. Eligible production side activities

Production side activities target the supply side and distribution of HFCs. Art. 6 activities could focus on incentivizing investments in new technologies and enhance private sector collaboration.

3.3.1. The likely ineligibility of HFC-23 destruction projects under Article 6 mechanisms

The specific regulations the KA introduces for the destruction of HFC-23 as by-product of HCFC-22 manufacturing should be a ground for excluding projects of HFC-23 destruction from both CAs and SDM. CDM methodologies and projects have proven that a far-reaching destruction of HFC-23 is technically feasible at a very low cost. The wide-spread bad reputation of HFC-23 CDM projects among NGOs and media will make it furthermore very unlikely that including these under Art. 6 will be acceptable for a large number of Parties to the UNFCCC, particularly key potential European Union Art. 6 buyer countries. Furthermore, costs for Art. 5 countries associated with HFC-23 destruction will be eligible for funding under the MLF. In contrast to the CDM situation, where additionality of HFC-23 destruction projects was without doubt, it would now become highly questionable. Production of all other 17 HFCs covered by the MP would still be eligible under Art. 6.

3.3.2. Eligibility of conversion of production lines to low GWP refrigerants

Programmes to convert production lines of HVAC equipment procedures from HFCs to low-GWP refrigerants offer potential mitigation opportunities while coming at high costs that could be covered through selling of credits. Art. 6 projects in this field could also cover regulatory support and training of maintenance personnel to ensure no loss in safety for users that enable penetration of alternatives to HFCs. Credit generation due to increase penetration would be contingent on the training being successful and overcoming the reluctance to implement the alternative solution. For production lines and operation, the largest costs would come with dealing with the different properties natural refrigerants pose; the higher pressure from CO_2 and flammability for ammonia, propane and butane as well as toxicity of ammonia. Adapting to these new properties requires changes in design, materials and machinery and in considerations during operation to guaranty the safety of the production process (ASHRAE 2011, Bentley 2017).

3.3.3. Crediting of policy instruments supporting production conversion

Art. 6 activities could credit policy instruments aiming to influence the supply side of the market, such as imposing a cap-and-trade system for HFC manufacturing linked to import regulations. Such policy instruments would be close to the imposed regulations by the KA and would therefore impose stricter regulations such as to demonstrate additional mitigation benefits. Under Art. 6.2 such cap-and-trade or also baseline-and-credit systems (ex-ante allocation of allowances vs. ex-post crediting) could be linked bilaterally or regionally between jurisdictions to broaden the market for allowances or credits and ensure a profitable price.

3.4. Eligible consumer side activities

Consumer side activities focus on shifting consumer demand from HFCs to alternative refrigerants and complement production side activities. Shifting consumer behavior can be either tackled bottom-up through incentivizing the distribution of low-GWP cooling appliances through PoAs or through the introduction of policy instruments.

3.4.1. Incentivizing the purchase and installation of low-GWP cooling appliances

Based on the small-scale methodologies developed under the CDM, AMS-III.A.B. for commercial and AMS-III.X. for domestic refrigeration (see chapter 3.2 on transition of CDM methodologies), programmes could be developed to incentivize the replacement of existing, high-GWP refrigerants. However, these programmes should be coupled with disposal approaches to avoid the piling up of HFC banks (see section 3.1.4 on HFC disposal activities). Programmes could lead to higher penetration rates of certain technologies in one or several countries and stimulate their development and commercial attractiveness.

3.4.2. Crediting for policy instruments for larger scale shifting of demand

The introduction of several policy instruments could be credited under Art. 6 mechanisms, such as the taxation of HFC-using appliances, with potentially using credit revenues to mitigate price effects for the most vulnerable populations. Less politically contentious would it be to design revenue-neutral end-use subsidy programmes for low-GWP cooling appliances. Also credited could be integrated training regulatory and sales outlet personnel training, offering bonuses for sold appliances, a policy that would tackle the retail sub-sector.

3.5. Transitioning the CDM experiences in light of the KA

With regards to the experiences with HFC mitigation projects gathered under the CDM, the key question to answer is: how do we get from where we are to where we want to be, i.e. how do we build upon the CDM to exploit the full potential of HFC mitigation under Article 6?

3.5.1. Transitioning methodologies to pursue activities under the KA and the PA

Future NDC reporting obligations require a certain level of harmonization and comparability of MRV standards. CDM methodologies are currently the only UNFCCC-approved MRV tools. The CDM methodologies for HFCs affected by the KA phase-down schedule should therefore be reevaluated and transitioned to the Art. 6 mechanisms if possible. Currently, there are two small-scale methodologies for consumption-side projects (AMS-III.A.B. for commercial refrigeration; AMS-III.X. for domestic refrigerants) as well as two small-scale methodologies for production side projects (AM0071 for production of domestic or small commercial refrigeration appliances; AM-III.N. for avoidance of HFC emission in the manufacturing of rigid Poly Urethane Foam (PUF)). The developed methodology AM0001 for the decomposition of HFC-23 waste streams should be used by the TEAP and the MLF to assess the financing of HFC-23 destruction projects under the KA.

3.5.2. Consider the transition of ongoing small-scale CDM projects to Article 6 mechanisms

Currently, there are only three small-scale registered CDM projects that reduce HFC emissions. All three projects are located in India and apply the methodology AM-III.N. avoiding HFC-134a emissions in rigid PUF manufacturing:

1) *Avoidance of HFC-134a emissions in rigid Poly Urethane Foam (PUF) manufacturing by Acme TelePower Limited (ATPL)*. Fixed crediting period of 10 years: November 2009-November 2019. No issuance of CERs has been achieved so far, with a current issuance delay of 108 months. The expected CERs for 2020 and 2030 are 245 $ktCO_2$.
2) *Avoidance of GHG emissions in rigid Poly Urethane Foam (PUF) manufacturing by LIL*. Fixed crediting period of 10 years: October 2009 – October 2019. No issuance of CERs has been achieved so far, with a current issuance delay of 109 months. The expected CERs for 2020 and 2030 are 215 $ktCO_2$.
3) *Avoidance of HFC-134a emissions in rigid Poly Urethane Foam (PUF)*. Fixed crediting period of 10 years: February 2011- February 2021. No issuance of CERs has been achieved so far, with a current issuance delay of 93 months. The expected CERs for 2020 and 2030 are 152 and 153 $ktCO_2$ respectively.

Once their crediting period is over, these projects may help with India's NDC target to reduce the emissions intensity of its GDP by 33 to 35 % by 2030 from 2005 level (Government of India 2016). Given that all these projects are not performing and their crediting period will end soon, and have not issued CERs, a transition to Art. 6 seems to be unlikely. Still, further assessment of these activities may be important for understanding how to design effective Art. 6 pilots on the consumption side. Given that India has recently published a national cooling plan in line with the KA as one of the first globally (Government of India 2018), it could be a highly important case study for such an examination.

3.5.3. Transition CDM instruments such as PoAs and standardized baselines that performed well

Programmes of Activities (PoAs) have been introduced to the CDM in order to lower transaction cost for small-scale activities and are the only activities that were able to survive the 2012 market crash to a large extent. They have proven to be especially able to yield high sustainable development benefits and valuable lessons in upscaling mitigation action (Michaelowa and Hoch 2016). The flexibility offered by this instrument, to add several small-scale projects over time to one package, has facilitated the development of demand-side projects, for instance in the field of energy efficiency overcoming the barriers of high transaction costs. PoAs can be used to upscale private investments in the field of shifting demand and changing manufacturing processes in small and medium sized enterprises (GIZ 2018a).

This potential of lowering barriers and unlock private sector participation can be enhanced in combination with the development of standardized baselines to facilitate additionality testing. Standardized baselines have been recognized by the CDM policy dialogue in 2012 as a valuable tool to develop further. These baselines should be set conservatively while applicable to a range of similar projects and contexts (UNFCCC 2012). Standardized baselines can be also used for MRV purposes even in the absence of credit issuance. They require, however, good data availability, which should be possible over time with the development of KA MRV systems and in an early phase with some piloting countries disposing of HFC data reporting systems. Therefore, piloting development of such baselines, potentially as element of Art. 6 activities, should initially focus on those countries with recognized good quality data availability (potentially Costa Rica, Ghana, Indonesia, Kenya, Seychelles). Building on the methodological tool published in 2017 for energy efficiency in HVAC and expanding it to HFC mitigation assessment would be a good starting point (see chapter 2.1.1). For countries with poorer data availability, technology benchmarks could be used as an interim solution.

4. Conclusions: Enhancing ambition by harnessing synergies of KA and PA

In order to allow for higher ambition through exploiting synergies, procedures, implementation plans and activities under the KA and PA should be integrated further and continuously synchronized. The KA has already proven that non-state actors can be mobilized to bring in financial and R&D resources, a goal the PA is also pursuing. Carefully designed Art. 6 activities can be key to unlock private sector

participation while ensuring environmental integrity of credits generated. Simultaneously, there should be safeguards to ensure that private commercial interests do not generate perverse outcomes that may prolong the use of high-GWP gases while innovation may yield more climate-friendly alternatives. This is crucial in light of the significant interests of large powerful corporations, whose future market potential for some products can be strongly affected by incentivizing certain HFC alternatives. As a starting point, MRV systems and data reporting under both agreements should be synchronized. HFC emission reporting must be included not only under the KA, but also in the NDCs and LEDS of the Paris Agreement. Then, the potential to support specific measures with Art.6 pilot activities should be explored further. Eventually, revenues from Art. 6 credits sales could become one of the key pillars of financing HFC reduction and enable countries to reach emissions paths that are lower than those defined by the KA.

4.1. Designing Article 6 activities in line with the KA

Our analysis of HFC projects and methodologies under the CDM in sections 1-3 above shows that there is significant potential to exploit lessons for the design of Art. 6 activities under the PA. Scalable programmatic approaches are particularly relevant for consumption-side based HFC reduction, whereas crediting the introduction of policy instruments that regulate the destruction or prohibition of HFC use or a grant programme for revamping of HVAC equipment production lines can substantially accelerate HFC phase-down.

Additionality determination is facilitated through KA phase-down schedules that provide clear and unequivocal baselines, and that should be taken into account in the context of the NDCs. Significant work is needed to operationalize these baselines in the context of specific HFC mitigation interventions, especially how to “apportion” the mitigation if an intervention has multiple sources of finance beyond the revenues from credit sales. Baselines for policy instruments will be quite simple as the KA phase-out schedule can directly be used as baseline. A key target for policy intervention is the destruction of HFC banks, as these are not addressed by the KA and thus the baseline is 100% of emissions from the existing HVAC systems containing HFCs.

In the period up to 2020, pilot Art. 6 activities should be developed in cooperation with Article 5 countries to address the acknowledgement of the KA HFC phase-down schedules as baselines in the revised NDCs, the development of policy crediting for regulation covering destruction of HFC banks and grant programmes to convert HVAC production lines, including standardized baseline methodologies, the establishment of robust MRV systems and data collection in line with Art. 6 accounting rules. These pilot activities should be conducted with pioneering countries in this field, for instance partner countries of the Green Cooling Initiative with good data availability and political will, or other early movers in the development of national HFC plans. India’s Cooling Action Plan (Government of India 2018) is the first attempt to reconcile growing cooling requirements with the phase-out of HFCs (Madan 2018). This is particularly relevant since the country has a huge CDM portfolio, a track recording of establishing further innovative mitigation policy instruments, as well as the domestic capacity to operationalize crediting mechanisms such as those envisioned by Art. 6. The earlier these pilot activities reach scale,

the lower HFC emissions will become in the baseline years of the KA. A coalition of industrialized countries developing a dedicated acquisition programme for early HFC reduction credits paying a premium for credits before the KA baseline years should therefore be considered. This premium could be linked to the cumulated volume of avoided emissions due to the reduction of the HFC baseline. Germany is currently generating relevant experience in innovative uses of market-based policy instruments in the context of its Nitric Acid Climate Action Group which could also inform such a process (NACAG 2018).

4.2. Supporting the KA through public climate finance

Given the scale of the HFC reduction challenge and the relatively small scale of resources channeled through the MLF, the question is whether Art. 6 revenues can address this challenge alone. The answer is a resounding no, given that the demand for Art. 6 credits still remains highly uncertain as well as the price that credits will eventually fetch. Therefore, it is important to mobilize further resources in an integrated approach to HFC reduction. Public climate finance should be used to cover public goods linked to HFC reduction such as the establishment of MRV systems, which is mandated by the KA and eligible for funding thereunder, as well as the introduction of safety-related training necessary to achieve high penetration of hydrocarbon refrigerants in Art. 5 countries. Such an integrated approach to blending different financial instruments can also help tailor investment cost and operation cost requirements to the context of specific instruments by balancing results-orientation with the need to access upfront investments. Moreover, public climate funding could cover higher cost mitigation options, such as research on new replacements for HFCs. In order to ensure a coordinated approach, the MLF should develop a collaboration programme with the GEF, GCF, MDBs and bilateral climate finance providers. In fact, at its thirtieth meeting in November 2018, the MOP called on the ExCom and Ozone Secretariat to liaise with other funds and financial institutions to explore mobilizing additional resources and, as appropriate, set up modalities for cooperation such as co-funding arrangements to maintain or enhance energy efficiency when phasing down HFCs (IISD 2018).

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Annex A: Controlled HFC substances added to the MP

Substance	100-year Global Warming Potential	Atmospheric life (years)*
Group I		
HFC-134	1 100	9.6
HFC-134a	1 430	14
HFC -143	353	3.4
HFC-245fa	1 030	7.6
HFC-365mfc	794	8.6
HFC-227ea	3 220	34.2
HFC-236cb	1 340	13.2
HFC-236ea	1 370	10
HFC-236fa	9 810	240
HFC-245ca	693	5.9
HFC-43-10mee	1 640	15
HFC-32	675	4.9
HFC-125	3 500	29
HFC-143a	4 470	52
HFC-41	92	2.6
HFC-152	53	0.5
HFC-152a	124	1.4
Group II		
HFC-23	14 800	270

Sources: UNEP 2016a, p. 52 (Annex F to the Montreal Protocol); IPCC 2001, p.47.; IPCC 2007

HFCs with an atmospheric lifetime of less than 20 years belong to the category of “Short-lived Climate Pollutants (UNEP 2017).

Annex B: Inclusion of HFCs in first round NDCs

Country	Excerpt from NDC
Australia	"The Australian Government is commencing the development of a range of policies that will reduce emissions into the post-2020 period, including […] the enhanced management of synthetic greenhouse gas emissions under ozone protection laws and the Montreal Protocol."
Barbados	Included in Footnote 17: „Barbados is committed to the provisions of the Montreal Protocol. […] HFCs are on the rise nationally and globally but Barbados is committed to the transition to natural refrigerants with no-Ozone Depleting Potential (ODP), and little or no-ODP. This aspect has not been included in the GHG mitigation scenarios that have been undertaken for this INDC."
Canada	"Canada has also committed to finalizing regulations to phase down the use of hydrofluorocarbons in line with the Kigali Amendment to the Montreal Protocol."
China	"To phase down the production and consumption of HFC-22 for controlled uses, with its production to be reduced by 35% from the 2010 level by 2020, and by 67.5% by 2025 and to achieve effective control of HFC-23 by 2020."
Ghana	Abatement of fluorinated-gases (HFC-22 and HFC-410A) from stationery air-conditions in the context of the Green Cooling Africa Initiative through a National ODS phase-out programme and the Management of ODS and product regulations (conditional part of NDC with 0.3 million USD investment needs)
Nigeria	"Here the adoption of standards for imported equipment will be considered, in particular in the field of refrigeration and air conditioning where there is a risk of dumping of HCFC and HFC installations that are being phased out in OECD countries."
USA*	"Under the Clean Air Act, the United States Environmental Protection Agency is moving to reduce the use and emissions of high-GWP HFCs through the Significant New Alternatives Policy program."
Swaziland	The consumption of HFCs, PFC and SF_6 gases will be phased out

Source: WRI & Oxfam 2018, p. 33; adapted by authors

* The intended NDC of the United States is no longer valid.